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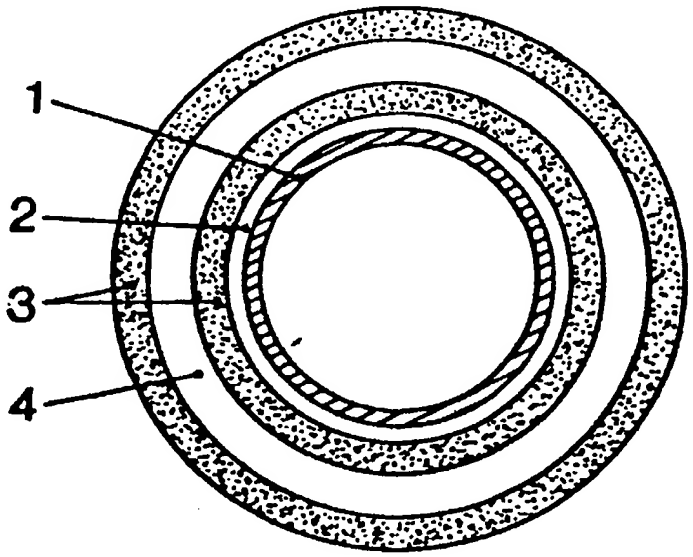

(57) Abstract

Combined weight- and insulation casing for subsea pipelines (1) and method for production of the casing. The casing is applied by extrusion of thermoplastics on to the pipes. This makes it possible to produce continuous lengths of insulated pipeline. Compact and foamed plastic with and without weight material incorporated into the plastic can be used. The casing can be formed of alternating layers of plastic with (3) and without (4) weight material. It is preferred to use polypropylene or polyvinyl chloride.

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Insulation and weight coating for subsea pipelines and method for production of the same

The application concernes a casing forming a combined insulation and weight coating for subsea pipelines and a method for producing the same.

The most commonly used weight coating for subsea pipelines has until now been reinforced concrete. It often arises cracks or damage in the concrete, something that can lead to that parts of the concrete coating is falling off, both during the pipelying process and afterwards. The concrete is stiff and in addition has poor insulating qualities. The stiffness of the concrete makes it impossible to use reel-laying of continous lengths of pipelines.

Weight coating is used on subsea pipelines both for protection and stable location at the sea bed. That the coatings at the same time have an insulating effect is important to avoid hydrate formation and wax formation and deposition in pipes carrying hydrocarbons. It therefore is made demands to the lowest allowed temperature in the pipeline. The temperature increases with the depth of the reservoirs. In the future the development leads to production from great depths. This therefore excludes traditional choice of materials.

From British patent No. 1.573.814 it is known to coat pipelines with a weight coating of elastic material, for example

rubber containing iron powder and ore if desired. Rubber is an expensive material and in addition it has poor insulating qualities.

Also in accordance with BRD published application No. 2.544.194 it is suggested rubber as a basic material for a pipecoating where the weight material is in the shape of steelbars incorporated into the rubber. This weight coating accordingly has the same drawbacks as the one according to the British patent.

In Norwegian patent No. 150 771 it is described a pipeline with weight coating where the coating is in the form of a composite material with granulated heavy metal ore casted into a matrix of thermoset and surrounded by a protecting sleeve of for example crossbonded polyethylene. The weight material representes the main part, about 85-95 weight % of the composite material. The outer sleeve is along its internal circumference formed with mutually separated, radially inwards directed knots or projections which causes centering of the outer casing on to the steel pipe with mutual radial distance adjusted to the wanted thickness of the composite layer. The knots at the same time work to anchor the outer plastic pipe to the composite layer which at the same time adheres to the surface of the steel pipe in such a way that a relative displacement between the steel pipe and the whole casing is practically excluded. Pipe with weight coating is produced by treading the outer pipe onto the steel pipe with the knots in contact with the surface of the steel pipe after which the composite mass is injected into and completely fills the annular space between the plastic pipe and the steel pipe. This gives a pipe which is hard to produce and reduces to production of separate lengths. With the said extent of filling (85-95 %) the product will be very stiff and unsuited for reel-laying.

An other used type of insulation is built up in layers of rubber and PVC-foam. PVC is put on in the shape of preformed blocks or as a bandage after which rubber bandages is applied. The rubbercoating must at last be vulcanized before the pipes can be used. This method does give pipes of good quality, but they are expensive to produce. The pipes also have reduced applications because of the thermic resistence of the PVC-foam (about 50-80^{o}C).

The object of the invention is to work out a casing which both gives good insulation and weight to pipelines and which at the same time is easy to apply.

Another object is to develope a coating which also is suited for continous applying and thereby makes it possible to produce continous lengths of pipe with a combined insulation/ weight material. This makes reel-laying possible, which both saves time and money. This also makes possible that quality control can be made on shore, and welding and inspeciton of joints by laying become superfluous.

Another object of the invention is to work out an insulation/weight-casing with optional shaped profile which makes it possible to collect several pipelines in one casing.

These and other objects of the invention are attained with the device and method described below, and the invention is characterized and defined with the accompanying patent claims.

An important feature of the invention is that the insulation/weight-casing is extruded on to the pipeline. Thereby pipelines can be coated in a rapid and reasonable way. For this use thermoplastics is suitable, and it is found that polyvinyl chloride (PVC) and polypropylene (PP) are especially useable. Both PVC and PP can be foamed to a wanted

degree. By extruding the coatings, a weight material also can be added to the plastic before coating. By leading the pipeline several times through the extruder, a casing can be formed in layers with compact and/or foamed plastic and with incorporated weight material if desired.

Other features of the invention are described more in detial below, and also shown in the drawings, figures 1A and B.

Figure 1A shows a casing with a combined insulation and weight coating, and figure 1B shows the casing formed in layers.

To be able to use reel-laying of pipes it is made demands on 3 % extention of pipe/coating. This can not be fulfiled for many of the stiff light foams which now are used for insulation of pipes. Thermic conductivity and water absorption, if the insulating material is exposed directly to seawater, are the basic demands for selection of the insulating material. Thermic conductivity must be less than 0,2 W/m·K. A greater water absorption than 5 % after 3 days of exposure and 10 % during a longer periode of time is not accepted. High degrees of foaming of the plastic materials also can give problems regarding waterabsorption.

Mechanical qualities in the light of installation-strain and pipe in operation are also important to consider. A change in dimension greater than 5 % can not be accepted. In addition it is made demands to the material durability with regard to light, heat, ageing etc.

One has found that some thermoplastics fulfil these demands and especially well suited is polypropylene (PP). Polyvinyl chloride (PVC) can also be used. When it in addititon has been possible to apply the plastic by continous extrusion also for pipes in the size of 4-10" (10,2-25,4 cm) a product which is easy and cheap to produce is obtained.

Thermoplastics can be used compact or foamed with or without weight material. As weight material heavy soluble minerals with high density can be used, for example bariumsulphate. This is added to the plastic mass before extruding. The plastic can be foamed by use of chemical foaming agent, a stable foam also can be obtained by adding microspheres of plastic or glass to the plastic melt.

Polypropylene is non-hygroskopic and can easily be foamed to the wanted density. Polypropylene foam has sufficient stiffness for use down to greater depths than 100 m, and it is thermical and dimensional stable until about 140° C. Compact polypropylene is in itself a good insulator and has a thermal conductivity at 0,2 W/m°K. PVC is a better insulator with thermal conductivity 0,15 W/m°K. PVC is about 50 % heavier than PP and with a density of 1, 49 g/cm^3. PVC is however only thermical stable as to about 80°C and is preferably used in compact form.

In figure 1A it is shown a pipeline with a combined insulation and weight casing 3. The steel pipe is first sandblasted/cleaned before a thin layer 2 for corrosion protection/adhesive is applied. For pipelines of this type the adhesion to the steel pipe is especially important. It has been used steel pipes treated with epoxy and with a adhesive layer of Admer Q B 540 (Mitsui). By extrusion of PP-foam it was used a PP-quality with high melt index, Hostalen PPR 1042 (Hoechst) and 1 part Genitron (50 %) (Shearing) as foaming agent. This to effect that the gas released by heating the foaming agent is dissolved into the melt in the best possible way. In this way a foam with uniform foam structure and small cells is obtained. An alternativ is to have the foaming agent incorporated into the raw material by the plastic producer.

The pipeline is heated to about 100°C before applying the coating. The coating is applied by continous extrusion by use of conventional apparatus. It is used temperatures from 160°C at the filling funnel increasing to 230-240°C at the extruder. The pressure was about 100 bar. For a 6" (15,3 cm) pipeline the thickness of the PP-layer was about 2" (about 5 cm). The adhesion to the steel was good. PP is in practice foamed up to 50 %. By higher degrees of foaming it can be a danger of water absorption if the foaming is not uniform.

Pipes with coating are cooled with cold water both outside and inside after the coating. This is important to avoid sagging/ovality of the coating. A right material can eventually be added to the plastic mass before extrusion.

In figure 1B a casing built up by layers is shown where 1 is the steel pipe and 2 is corrosion protection/adhesive. The number 3 indicates a layer filled with minerals and 4 is a compact or foamed thermoplastics layer, a casing composed of several layers makes it necessary to pass the pipe through the extruder many times: The advantage of this construction of the pipe is that the properties can be tailored to the use.

By applying of a casing by extrusion it is possible to produce continous lengths of pipe, but there is no limitation as to how short pipelines you can produce.

It is made demands to that weight of ballast/density for pipes (this includes oil, gas, steel pipe, insulation etc.) shall be in the order of 1100-1200 kg/m^3. The thickness of the casing and degree of foaming of the plastic and also the content of weight material therefore is dependent of diametre and length of the pipe. For ordinary pipelines for oil the pipe/insulationcoating as a rule is heavy enough so that further addition of weight material is not necessary.

For a 6,2 km long subsea oil production flowline with a diametre of about 15 cm the following conditions will be in force: To maintain temperatures above the hydrate formation temperature during a periode of six hours after a line shutdown, one will need a heat transfer coefficent around 3 $W/m^2 \cdot K$. This can be achieved by 6 cm of an insulation material with a thermal conductivity of 0,15 W/m°K, which can be a 40 % foamed polypropylene.

By this invention it is attained a combined weight coating insulating layer which is easy to apply. By extrusion of thermoplastics on to the steel pipe continous pipe lengths can be coated if this is wanted. This makes reel-laying possible. The layer is however also suited for pipes of greater diameter and shorter lengths. By extrusion of the coating the layer can if wanted be built in layers of alternating foamed or compact plastic or plastic with filler to wanted thickness, extent of insulation and weight. The coatings thus can be tailored to suit the individual need.

It is also possible to produce casings with different profiles in such a way that a possible wish of triangular profil for stability on the seabed can be met. This gives possibility for combined solutions where several pipelines can be gathered in the casing or where for example electrical signal cables or electrical powercables can be integrated into the pipecasing.

Claims

1. Combined weight- and insulation casing for subsea pipelines
characterized by that
the pipes (1) are coated with an insulating layer (3,4) of foamed and/or compact polypropylene or polyvinyl chloride and with a weight material incorporated in the plastic if desired.

2. Device according to claim 1
characterized by that
the coating is applied by extrusion.

3. Device according to claim 1
characterized by that
the weight material is a mineral of high density.

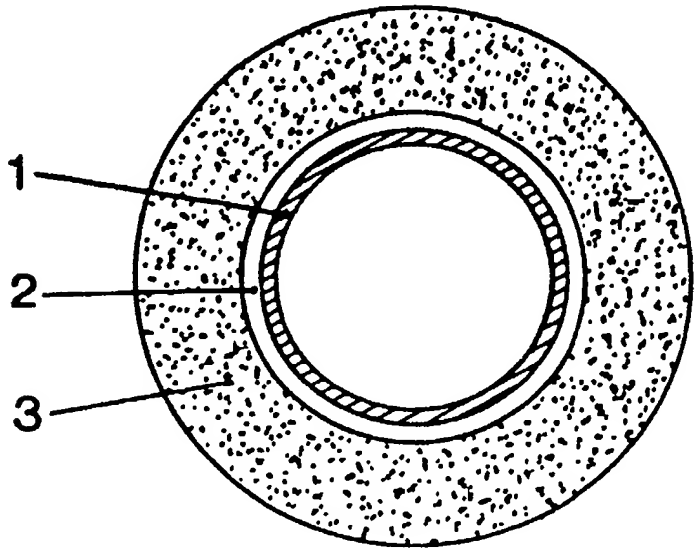
4. Device according to claim 1
characterized by that
the insulating coating (3,4) is built up in layers with alternating layers of plastic with and/or without weight material incorperated into the plastic.

5. Device according to claim 1
characterized by that
several pipelines and/or cables are gathered in one casing.

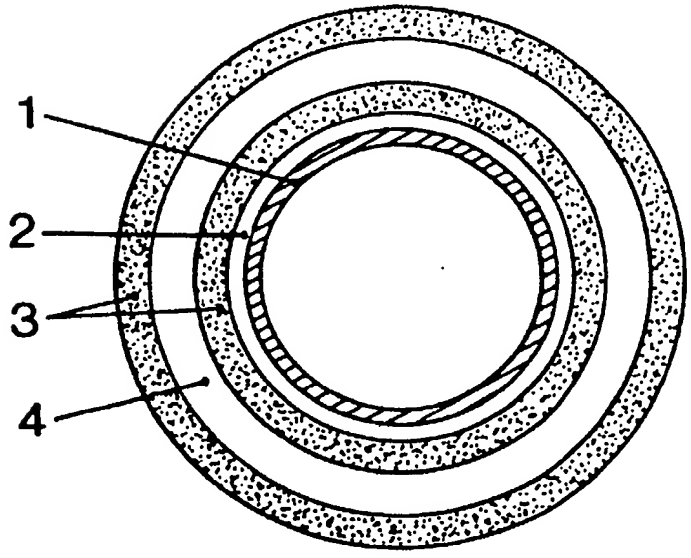
6. Method for production of a combined weight- and insulation casing for subsea pipelines,
characterized by that
the pipes (1) are coated with an insulating casing (3,4) of a foamed and/or compact polypropylene or polyvinyl chloride by extrusion, and where a weight material can be incorporated into the plastic.

7. Method according to claim 6
c h a r a c t e r i z e d b y t h a t
the weight- and insulation casing (3,4) is built in layers by extrusion of alternating layers of foamed and/or compact thermoplastic with or without incorporated weight material on the pipelines.

8. Method according to claim 6
c h a r a c t e r i z e d by t h a t
the thermoplastic is foamed by help of chemical foaming agents or is filled with microspheres.



A.



B.

Fig 1

INTERNATIONAL SEARCH REPORT

International Application No PCT/NO87/00011

I. CLASSIFICATI N OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

F 16 L 57/00, F 16 L 1/04 4

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	F 16 L 1/04, 57/00, 58/10, 59/14
US Cl	138:103, 111, 114, 140, 145, 146, 149, 177

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	GB, A, 1 549 847 (W R GRACE) 8 August 1979 See page 1, lines 57-60 and 80-85. & BE, 840617 NL, 7603775 FR, 2307213 DE, 2614793 JP, 51124826 AU, 508582 CH, 620025 CA, 1090691 CA, 1103141	1-4
Y	DE, A1, 2 051 596 (KABEL - UND METALLWERKE GUTEHOFFNUNGSHÜTTE) 4 May 1972 See page 2, lines 19-23 and page 3, line 4. & FR, 2112324 GB, 1305999 BE, 770042	1, 2, 6-8

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1987-05-08	1987 -05- 12
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Swedish Patent Office	Erik Svensson Erik Svensson

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	DE, A1, 2 751 945 (USTAV PRO VYZKUM A VYUZITI PALIV) 8 June 1978 See claim 1 and page 4, lines 22-30. & JP, 53069921	1-4
Y	GB, A, 1 573 814 (MANNESMANN) 28 August 1980 See page 1, lines 43-48. & FR, 2338131 DE, 2601990	3
Y	CH, A5, 600 234 (J G H LILLJEQVIST) 15 June 1978 See fig. 3.	5